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CLAIMS

1. An embolic protection device comprising:

5 a collapsible filter element mounted on a filter carrier for delivery through a vascular system of a patient,

the filter element being movable between a collapsed stored position against the filter carrier for movement through the vascular system, and an expanded position for occluding a blood vessel such that blood passing through the blood vessel is delivered through the filter element,

10 the filter element comprising a collapsible filter body having an inlet end and an outlet end,

the inlet end of the filter body having one or more inlet openings sized to allow blood and embolic material enter the filter body,

20 the outlet end of the filter body having a plurality of outlet openings sized to allow through passage of blood but to retain undesired embolic material within the filter body,

means for closing the inlet openings at the inlet end of the filter body, and

means for collapsing the filter body on the support.

2. A device as claimed in claim 1, wherein the means for closing the inlet openings comprises:-

30 a tubular filter retrieval device having an open distal end for reception of the filter element,

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said distal end being engagable with a proximal inlet end of the filter body to close the inlet openings and being slidable over the filter body from the inlet end to the outlet end to progressively collapse the filter body on the filter carrier and receive the filter body within the retrieval device.

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3. A device as claimed in claim 1 wherein the collapsible filter element is slidably mounted on the filter carrier between a pair of spaced-apart stops on the filter carrier for axial movement of the filter element along the filter carrier between the stops.

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4. A device as claimed in claim 3, wherein the filter element is rotatably mounted on the filter carrier.

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5. A device as claimed in claim 3, wherein a sleeve is slidably mounted on the filter carrier between the stops, the length of the sleeve being less than the distance between the stops, the filter element being mounted on the sleeve.

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6. A device as claimed in claim 1, wherein the filter element comprises:-

a collapsible filter net mounted on the filter carrier,

the filter net being movable between a collapsed stored position against the filter carrier and an expanded position extending outwardly of the filter carrier for deployment across a blood vessel

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7. A device as claimed in claim 2, wherein the tubular filter retrieval device comprises a catheter slidable along the filter carrier, an open distal end of the catheter forming a housing for reception of the filter element.

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8. A device as claimed in claim 1, wherein a proximal inlet end of the filter body is fixed to the filter carrier and a distal end of the filter body is slidably mounted on the filter carrier..

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- 5 9. A device as claimed in claims 1 wherein a filter support frame is mounted on the filter carrier, the support frame being movable between a collapsed position along the filter carrier and an extended outwardly projecting position to support the filter body in the expanded position.
- 10 10. A device as claimed in claim 9 wherein the filter support frame is fixed on the filter carrier at a proximal end of the filter body, and the filter support frame slidably engages the filter carrier at a distal end of the filter body.
11. A device as claimed in claim 9 wherein the filter support frame is biased into a normally extended position.
- 15 12. A device as claimed in claim 9 wherein a circumferential groove is provided in the filter body intermediate the ends of the filter body.
- 20 13. A device as claimed in claim 1, wherein a guide olive is provided on the filter carrier distally of the filter body, the guide olive having a cylindrical body with a tapered distal end, the cylindrical body being engagable within a distal end of a deployment catheter, said tapered distal end projecting outwardly of the deployment catheter to provide a smooth transition between the catheter and the filter carrier.
- 25 14. A device as claimed in claim 1 wherein the filter element includes storage means to store captured undesired embolic material in the filter element.
15. A device as claimed in claim 14 wherein the storage means comprises additional storage pathways within the filter element.
- 30 16. A device as claimed in claim 1 wherein the filter element defines a three dimensional matrix.
17. A device as claimed in claim 16 wherein the filter element is of a polymeric porous structure.

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18. A device as claimed in claim 16 wherein the matrix comprises a porous structure dimensioned to entrap embolic material ranging in size from 100 microns to 3500 microns.

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19. A device as claimed in claim 1 wherein the filter element has a distal end which is tapered such that there is a smooth transition in lateral stiffness to improve the manoeuvrability of the filter element in the vascular system.

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20. A device as claimed in claim 1 wherein the filter element has a soft distal portion to aid in atraumatic transport through the vascular system.

21. A device as claimed in claim 1 wherein the filter element has a tapered proximal end to facilitate retrieval by a removal catheter.

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22. A device as claimed in claim 1 wherein the filter element has inlet holes that close on pulling back into a retrieval catheter to ensure retention of any collected emboli.

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23. A device as claimed claim 1 having means for placing the device over a medical guidewire.

24. A device as claimed in claim 23 which may be placed under a balloon or stent delivery catheter.

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25. A device as claimed in any preceding claim including a delivery catheter in which an external sheath is engagable with the filter element or filter carrier to provide push during delivery and is removable to allow maximum space in the vascular cross-section during an interventional procedure.

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26. A device as claimed in claim 25 wherein the external sheath is joined to the filter element or filter carrier by a joining means.

27. A device as claimed in claim 25 wherein the delivery catheter has a central

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lumen for at least part of it's length to allow it to track over a steerable guidewire.

- 5 28. A device as claimed in claim 25, wherein the external sheath is sufficiently long to extend to the outside of the vasculature and is removable proximally to release the filter element from the catheter.
- 10 29. A device as claimed in claim 25, wherein the delivery catheter has an external covering which extends beyond the push element to define a filter retention sleeve.
- 15 30. A device as claimed in claim 1 wherein the filter element is mounted on a collapsible support frame which is movable between a collapsed position for deployment and an extended in-use position, means being provided for retaining the support structure in the collapsed position.
- 20 31. A device as claimed in claim 30 wherein the support frame is formed from a shape memory or elastic memory material.
- 25 32. A device as claimed in claim 1 wherein the filter element has an associated support structure with a pre-shaped spiral arrangement such that it provides radial support to the filter element.
33. A device as claimed in claim 1 wherein the filter has a support structure adapted to fold into the collapsed position when pulled into a retrieval catheter.
34. A device as claimed in claim 1 wherein the filter element comprises a flexible shaped polymeric component.
- 30 35. A device as claimed in claim 1 wherein the filter element is directly bonded onto a steerable medical guide wire incorporating a slidable sheath that is movable to deploy the filter.
36. A device as claimed in claim 1 incorporating a medical guidewire with a

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flexible segment of wire distal to the filter so as to provide steerability of the wire particularly prior to it being deployed.

37. A device as claimed in claim 1 incorporating a medical guide wire with a soft
5 distal segment so as to provide a tip section that will be atraumatic.

38. A device as claimed in claim 1 having a filter element which permits the
incorporation of a medical guide wire in or near the outer wall of the filter
element to facilitate the incorporation of large inlet holes on the proximal inlet
10 end of the filter element.

39. A device as claimed in claim 1 wherein the filter element comprises a mesh
work structure with large proximal inlet holes and small distal outlet holes
wherein the mesh structure is collapsible into a small diameter delivery
15 catheter and is expandable upon deployment to a shape which is remembered
by the mesh structure either through shape memory characteristics or elastic
memory characteristics.

40. A device as claimed in claim 1 wherein the filter element comprises a braided
20 fibrous meshwork.

41. A filter retrieval system for use with the device as claimed in any preceding
claim comprising a longitudinal catheter with a deformable tip to assist the pull
25 back of the filter into it.

42. A method for the capture and removal of embolic material from a blood vessel
during an interventional procedure comprising the steps:

30 preparing an embolic protection device comprising a guidewire having
a proximal end and a distal end, a collapsible filter element mounted
adjacent the distal end of the guidewire, the filter element being
movable between a collapsed stored position against the guidewire
and an expanded position extending laterally outwardly of the
guidewire,

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sliding a catheter along the guidewire and over the filter element from a proximal inlet end of the filter to collapse and house the filter in a distal end of the catheter,

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introducing the distal end of the catheter into the vascular system of a patient,

positioning the distal end at a desired location in the blood vessel,

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holding the guidewire and retracting the catheter to release the filter element from the catheter into the expanded position,

filtering blood in the vessel during the interventional procedure,

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after the interventional procedure advancing a retrieval catheter along the guidewire to engage a proximal inlet end of the filter,

collapsing the filter into the distal end of the catheter, and

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withdrawing the catheter from the patient.

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